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Enlightenment of the comparison of innovative cities in the Guangdong-Hong Kong-Macao Greater Bay Area to urban innovation in Dongguan

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Abstract. The innovation patterns of cities in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) show prominent differentiation. Shenzhen takes original innovation and high-intensity Research and Development (R&D) investment as the core driver of urban innovation; Guangzhou focuses on scientific and educational resources and comprehensive innovation. Although Dongguan is a strong manufacturing city with R&D intensity ranking among the top in the GBA, it still faces shortcomings such as weak basic research, insufficient high-end talents, an imperfect achievement transformation chain, and inadequate collaborative innovation mechanisms compared with Guangzhou, Shenzhen, Hong Kong and Macao. By comparing the innovation capabilities of core cities in the GBA, this paper identifies the bottlenecks of urban innovation in Dongguan and proposes development paths, providing a reference for the construction of an innovative city in Dongguan.

Keywords: Guangdong-Hong Kong-Macao Greater Bay Area, urban innovation, Dongguan

1. Introduction

The pilot policy for national innovative cities is a crucial manifestation of China's efforts to build an innovative country and implement the innovation-driven development strategy. To address the challenges of insufficient technological innovation capabilities since the reform and opening-up, the State Council issued the *"National Medium- and Long-Term Science and Technology Development Plan Outline (2006-2020)*" (*State Council Document No. 44 [2005]*), proposing to make the construction of an innovative country a major strategic choice for the future [1]. At the *Fifth Plenary Session of the 19th CPC Central Committee* in 2020, it was emphasized that "innovation must be given core status in China's modernization drive, and self-reliance in science and technology must be made a strategic pillar for national development", providing strong momentum for modernization through technological innovation: China is undergoing a transition toward innovation-driven development, and enhancing urban innovation capacity can facilitate the transformation of urban economic growth models, holding significant importance for achieving the goal of building an innovative country [2]. Urban innovation refers to the process of diversifying the operation of various technological capitals, innovative talents, and intensive, efficient innovation activities within city boundaries.

Urban innovation capacity reflects the competitive performance of a city's innovation level, embodying its innovative cohesion and influence, and plays a vital role in driving regional economic growth and enhancing comprehensive competitiveness, ultimately determining a city's future development [3]. As China's economy enters a new era and faces an increasingly dynamic and complex global economic environment, competition among city clusters centered around core cities is intensifying. Urban innovation capacity has become a key indicator and decisive factor in regional comprehensive competitiveness.

2. Construction of innovative cities in the Guangdong-Hong Kong-Macao Greater Bay Area

The *National Innovative City Pilot Policy* is aimed at building an innovative country and implementing the innovation driven development strategy. China launched the innovative city pilot program in 2008, and the China Institute of Science and Technology Information Technology divided 78 innovative cities into five categories in the "*National Innovative City Innovation Capability Evaluation Report (2019)*": science and education resource rich; Industrial technology innovation type; Innovation and entrepreneurship active type; Open collaborative innovation type; Supporting green development type [4]. As one of the regions with the highest degree of openness and economic vitality in China, the Guangdong-Hong Kong-Macao Greater Bay Area holds a significant strategic position in the overall national innovation and development. Among them, Guangzhou, Shenzhen, Dongguan, and Foshan have all been successfully selected into the list of 78 innovative cities, becoming the core engines of innovation and development in the Greater Bay Area. According to the data from the "*National Evaluation Report on the Innovation Capability of Innovative Cities (2019)*", the innovation capabilities of the four cities exhibit gradient differences and demonstrate outstanding overall performance: Shenzhen ranks first among national innovative cities with an urban innovation capability index of 83.8, Guangzhou ranks third with an innovation capability index of 77.65, while Dongguan (59.24) and Foshan (56.73) rank 28th and 34th respectively, forming an innovative development pattern of "leading from the top and collaborative echelon", highlighting the strong innovation strength of the Guangdong-Hong Kong-Macao Greater Bay Area.

Based on the five classification criteria, the four cities belong to different innovation types due to their differences in resource endowments and city positioning. Guangzhou, with its city positioning as a national central city, science and technology cultural center, and international metropolis, as well as its dense educational and scientific resources, falls into the science and education resource-rich category among the five types, driven by the dual engines of science and education coupled with industry. Shenzhen, Dongguan, and Foshan all belong to the industrial technology innovation category. Industrial technology innovation is a market-oriented, enterprise-centered, systematic activity aimed at enhancing industrial competitiveness, covering the entire chain from "new technology research and development—pilot testing—mass production—commercialization—industrialization". Its core lies in the industrialization of technological achievements and the upgrading of industries towards high-end development. The core characteristics of industrial technology innovation are firstly, enterprise-led, with a dense concentration of high-tech enterprises, a strong manufacturing foundation, and high market activity; secondly, efficient transformation, focusing on technology application and industrialization, rapidly transforming innovative achievements into practical productivity. Compared to cities with rich science and education resources, they have relatively weak original innovation links; finally, distinct indicator focus, focusing on core indicators such as the number of high-tech enterprises, R&D investment in industrial enterprises above designated size, industrialization rate of invention

patents, and the proportion of manufacturing value added, forming an innovation evaluation system that aligns with the actual development of industries.

3. Comparison of innovative cities in the Guangdong-Hong Kong-Macao Greater Bay Area

Among the four national innovative pilot cities in the Guangdong Hong Kong Macao Greater Bay Area, each relies on its own scientific and educational strength, industrial structure, and policy advantages, showing obvious differentiation characteristics in innovation investment, innovation output, industrial upgrading, and collaborative opening, forming a hierarchical and complementary innovation pattern [5]. There are innovation leaders such as Shenzhen and Guangzhou, manufacturing innovation transformation cities such as Dongguan and Foshan, plus international scientific and technological innovation resources from Hong Kong and Macao. This paper selects Shenzhen, Dongguan and Foshan—all industrial technological innovation cities—and compares core indicators including R&D expenditure, R&D intensity, number of high-tech enterprises, national "Little Giant" enterprises, value-added of strategic emerging industries, and innovation positioning, to identify strengths, weaknesses and bottlenecks.

Table 1. Comparison of core urban innovation indicators (2024)

Indicator	Shenzhen	Dongguan	Foshan
R&D Expenditure (100 million yuan)	2,453.07	492.11	298.27
R&D Investment Intensity (%)	6.67	4.01	~3.00
Number of National High-Tech Enterprises	25,700	10,200	9,330
Number of National "Little Giant" Enterprises	1,333	300+	200+
Value-Added of Strategic Emerging Industries (100 million yuan)	14,500	~5,000	~4,000
Innovation Positioning	Original innovation, R&D & design, headquarters economy	Technology commercialization, advanced manufacturing, pilot incubation	Applied innovation, smart home, equipment manufacturing

Data Sources: *Statistical Bulletin of Science and Technology Investment in Guangdong Province; Municipal Government Public Reports*

Based on the data in Table 1, Shenzhen stands out as a leader in innovation, with R&D expenditure and investment intensity far exceeding those of Dongguan and Foshan, highlighting its clear orientation towards supporting original innovation through high-intensity R&D investment. In terms of cultivating innovation entities, the number of national high-tech enterprises ranks among the top in the country. Shenzhen has always adhered to market-oriented innovation, established a technological innovation system with enterprise innovation as the mainstay, and nurtured a number of world-leading innovative enterprises represented by Huawei and Tencent. Although Dongguan ranks second to Shenzhen in various core indicators among Bay

Area cities, its strategic emerging industries have generated an added value of approximately 500 billion yuan, demonstrating strong capability in transforming research results. Songshan Lake Science City has been included in the pilot launch area of the Comprehensive National Science Center of the Greater Bay Area, and Dongguan is carrying the strategic mission of national technological development, with technological innovation elevating from a "local team" to a "national team". Foshan, based on its industrial foundation, follows a distinctive development path of "applied innovation, smart home, and equipment manufacturing", focusing technological innovation on the needs of industrial upgrading and promoting the transformation of traditional manufacturing towards intelligence and high-end products. Although its core innovation indicators are not as good as those of Shenzhen and Dongguan, the presence of 9,330 national high-tech enterprises and the added value of strategic emerging industries of approximately 400 billion yuan demonstrate its solid foundation in the field of applied innovation.

4. Bottlenecks restricting urban innovation in Dongguan

4.1. Insufficient density of high-end innovation resources

Major technological platforms and universities are the main carriers of high-end innovation resources. Firstly, although Dongguan has included Songshan Lake Science City in the pilot launch area of the Greater Bay Area (GBA) Comprehensive National Science Center, it is attempting to build a whole-process innovation chain encompassing "source innovation, technological breakthroughs, achievement transformation, technology finance, and talent support" under the guidance of the GBA Comprehensive National Science Center construction. The first cash attosecond laser facility in Asia and the second in the world has been confirmed to be located in Dongguan, but construction will only commence in 2025. According to the officially announced construction period, it will take at least five years, and it is expected to be completed and put into use around 2030. Currently, the Hash Neutron Source has only entered the second phase of construction. Although Dongguan has organized a chain-like collaborative approach to tackle key issues and established the first batch of 23 pilot experimental platforms and other major technological platforms, it will take time for these platforms to demonstrate their effectiveness. Secondly, as of now, Dongguan has a total of nine universities, and the City University of Hong Kong (Dongguan) has officially started enrolling students and has commenced operations. The University of the Bay Area (Songshan Lake Campus) has also been put into use, and Dongguan University of Technology has added two disciplines that rank in the top 1% globally according to the Essential Science Indicators (ESI) database. However, compared to Guangzhou, which has 84 universities, and Shenzhen, which has 17, Dongguan's universities, as carriers of high-end innovation resources, are still too weak. The most critical issue is that the existing universities in Dongguan still have a significant gap compared to high-level universities. The low proportion of high-end R&D talents, the large talent gap, weak basic research capabilities, insufficient original innovation capabilities, and the low density of high-end innovation resources are clearly major bottlenecks restricting urban innovation in Dongguan.

4.2. Low industrial level and heavy transformation pressure

Dongguan is known as the "World Factory", with manufacturing as its backbone. It has established an "8+8+4" industrial system, based on 8 traditional industries such as food, paper making, textile and apparel, chemical manufacturing, furniture, and packaging and printing; driven by 8 strategic emerging industries including new-generation electronic information, high-end equipment manufacturing, semiconductors and integrated circuits, new energy, artificial intelligence, and biomedicine, which serve as engines for industrial development; and driving the development of 4 future industries such as next-generation mobile

communications, cutting-edge new materials, intelligent robots, and future life and health. However, this industrial system currently clearly exhibits the characteristics of "strong manufacturing, weak innovation, strong application, and weak source", and is positioned in the mid-to-low end of the innovation chain in the Greater Bay Area. Firstly, from the perspective of basic research, Dongguan's investment is less than 3%, and almost all of it is used in enterprise application-oriented research and development. As can be seen from the table above, the number of high-tech enterprises in Dongguan is 10,200, but they are mainly small and medium-sized manufacturing enterprises, with terminal Original Equipment Manufacturers (OEM) and assembly as the leading industries. Strategic emerging industries are currently dominated by assembly, OEM, and component supporting. Biomedicine, AI, and new energy have not yet formed trillion-level clusters. The industrial system is essentially a "processing workshop" in the global industrial chain rather than an "innovation cradle". The industrial level is relatively low, with high pressure on future transformation and upgrading, long cultivation cycles, and large investment.

4.3. Mismatched urban functional capacity

The city's ability to gather and radiate, as well as its comprehensive urban functions such as culture, economy, environment, and management, are important manifestations of its innovation capability. As a "Double-Ten City" and an important node city in the Guangdong-Hong Kong-Macao Greater Bay Area, a national advanced road base, and a carrier of the International Science and Innovation Center, Dongguan has a significant economic manufacturing capability, but its comprehensive service capability is relatively low. Culturally, Dongguan's cultural industry generates an added value of approximately 60 billion yuan [6], which is significantly lower than that of Guangzhou (over 200 billion yuan) and Shenzhen (over 250 billion yuan). Furthermore, Dongguan lacks universities ranked among the "985 Project" and "211 Project" and has no national cultural centers, indicating notable deficiencies in the city's cultural functions. Environmentally, Dongguan has made efforts to create a water town ecological environment, but the southern part is densely populated with industries, leading to uneven regional ecology. The pressure on industrial solid waste and hazardous waste disposal is high, with land openness reaching 56.6% and severe land fragmentation, which severely restricts the contiguous protection of the ecological environment and the implementation of major projects. In terms of urban governance, Dongguan has a unique two-tier administrative structure at the municipal and town levels, which disperses limited fiscal resources among towns and streets. Although the overall intensity of fiscal expenditure can be reduced, Dongguan's tax retention ratio is only 38%, significantly lower than that of Guangzhou (about 55%) and Shenzhen (about 60%). The 32 towns and streets operate independently, exhibiting fragmented planning, a lack of a strong center, and a significantly weak municipal coordination capability. Overall, the level of urban functions needs to be improved.

4.4. Intense regional competition and escalating resource competition

In the urban system of the Guangdong-Hong Kong-Macao Greater Bay Area, Guangzhou, as a national central city and a highland of Lingnan culture, science, and education, boasts top universities such as Sun Yat-sen University and South China University of Technology, both ranked among the "985 Project" and "211 Project" universities, and over 150 various research institutes. Shenzhen, as a special economic zone, national innovative city, and financial center, has also gathered distinctive high-level universities such as Shenzhen University and Southern University of Science and Technology, with over 200 various research institutes. The number of PCT international patent applications has reached 16,347, and the R&D investment intensity has reached 6.46% [7]. Leveraging its policy dividends, comprehensive high-end factor supporting system, and strong resource aggregation capability, Guangzhou and Shenzhen have exerted a significant siphon effect on

surrounding cities. Dongguan, as a node city geographically close to Guangzhou and Shenzhen and highly correlated with their industries, has become one of the main affected areas where high-end resources are siphoned off. Meanwhile, in the urban system of the Guangdong-Hong Kong-Macao Greater Bay Area, cities such as Foshan, Huizhou, and Zhongshan have accelerated their layouts in the manufacturing and technological innovation fields, leading to fierce regional competition. The electronics industry in Huizhou has grown by 15.9%, surpassing Dongguan's growth rate of around 10%. Robot production in Foshan has increased by 30.6%, and equipment manufacturing investment in Zhongshan has grown by over 20%. With direct competition in the homogenized manufacturing sector, Dongguan's advantages have been significantly weakened, and its development space has been comprehensively squeezed.

4.5. Rising uncertainty in the external environment

The industrial system structure of Dongguan mentioned earlier is 8 + 8 + 4, where the electronic information industry is "large but not strong". In the mode of assembly + OEM + component supporting, the dependence on imported components from Xing is over 70%. The US "*Chip and Science Act*" restricts the export of advanced processes below 14 nm to China, increasing the risk of supply disruptions for core components of Dongguan's 5G equipment, high-end mobile phones, and AI server enterprises. The "bottleneck" in high-end technology directly restricts the industry's upgrade to high value-added and high-tech content, locking Dongguan in the mid-to-low-end manufacturing sector for a long time without breakthrough. In addition, the export proportion of electronic information products in Dongguan in 2025 was about 46.4%, but in the same year, the US imposed an average tariff of 48% on Chinese electronics and other goods in its tariffs on China, with some categories (such as notebook components and toys) facing tariffs as high as 84%-125%, resulting in a sharp decline in Dongguan's export growth to the US. The uncertainty of external environments such as trade protectionism and intensified technological blockades has a significant impact on Dongguan's industrial system, and the security risks of industrial and supply chains have increased significantly.

5. Development paths for urban innovation in Dongguan

Urban innovation cannot follow a uniform model; each city must explore a path tailored to its scientific and technological foundation, resource endowments, industrial characteristics, geographical advantages and development level.

5.1. Strengthen innovation sources and compensate for original innovation deficiencies

To accelerate the construction of university device application scenarios, Dongguan should leverage large scientific devices to establish a full-chain innovation ecosystem encompassing "basic research + technological breakthroughs + achievement transformation". It is imperative to vigorously support universities in the Greater Bay Area and the City University of Hong Kong (Dongguan) in enhancing their basic research capabilities, while encouraging enterprises and universities to jointly tackle "bottleneck" technologies. Simultaneously, the construction of major scientific and technological infrastructure such as the second phase of the Spallation Neutron Source and the Advanced Attosecond Laser Facility should be accelerated. Furthermore, the advancement of the first domestically produced boron neutron capture therapy equipment into clinical trials, the expedited development of the first China-Latin America technology transfer center at the Dongguan Institute of Materials Research, Chinese Academy of Sciences, and the creation of an innovative scenario where large scientific devices and advanced production lines are situated in close proximity should be pursued, striving to make these unique advantages for Dongguan.

5.2. Promote industrial upgrading and build a modern industrial system

First, drive intelligent and green transformation of 8 traditional industries. Implement the Smart Manufacturing Empowerment Plan to achieve full digital transformation of industrial enterprises above designated size; promote green manufacturing technologies to reduce energy consumption and emissions and increase added value. Upgrade clothing, food and beverage, papermaking and packaging toward the high end; encourage consumer electronics, trendy toys, home furnishings and watch accessories to embrace national fashion trends and create more Dongguan Quality Products to drive in-depth transformation. Second, promote clustering of strategic emerging industries. Build a national AI application demonstration zone and pilot base in the Binhai Bay New Area; expand application scenarios for autonomous driving, smart factories and AI terminals; cultivate leading enterprises and trillion-level clusters in AI, robotics, semiconductors, new materials, new energy, biomedicine and low-altitude economy to build a modern industrial system.

5.3. Optimize spatial layout and improve urban functional quality

Break administrative barriers; coordinate industrial, transportation and public service layouts; shift from "one town, one product" to multi-town joint industrial clusters. Empower strong towns to enhance governance and inter-town coordination. Increase investment in education, healthcare, housing and green spaces; create a livable environment of green spaces within walking distance and parks accessible on foot to attract high-end talents. Develop the Binhai Bay New Area as a hub for innovation, headquarters and high-end talent communities to absorb innovation spillovers from Guangzhou and Shenzhen, optimize spatial layout and improve urban functions.

5.4. Deepen GBA coordination and integrate into national development strategy

The Songshan Lake Science City (pilot start-up area of the GBA Comprehensive National Science Center) has established a science alliance with Shenzhen's Guangming Science City, demonstrating Dongguan's commitment to GBA coordination. Innovation coordination will be the core engine for GBA participation. Dongguan should deepen cooperation with Hong Kong and Macao innovation resources, absorb high-end manufacturing and innovation service spillovers from Guangzhou and Shenzhen, and build an industrial division system of Guangzhou–Shenzhen R&D + Dongguan Manufacturing. Jointly build modern service industry cooperation zones with Hong Kong and Macao to develop producer services (finance, logistics, R&D design) supporting advanced manufacturing, integrate into national strategy and contribute to Chinese-style modernization.

5.5. Reform institutional mechanisms and stimulate market vitality

Two rounds of the *Ten-Hundred-Thousand-Million Talent Project* have attracted over 510 national/provincial talent recipients, 18 academicians, 280,000 high-level talents and 1.83 million skilled talents, with talent attractiveness ranking top three among prefecture-level cities nationwide. Upgrading talent policies is the foundation. Next, reform the scientific and technological system: grant greater autonomy to universities and research institutes; support researcher entrepreneurship and technology transfer; strengthen Intellectual Property Rights (IPR) protection and revenue sharing to increase researchers' transformation income. Establish a municipal innovation mother fund; develop tech-finance products to ease Small and Medium-sized Enterprise (SME) financing difficulties and stimulate market vitality.

6. Conclusion

In the Guangdong-Hong Kong-Macao Greater Bay Area, Shenzhen and Guangzhou, as innovation leaders, exhibit characteristics of "strong original innovation, agglomeration of high-end factors, and efficient technology transfer". In contrast, although Dongguan has formed its own unique urban innovation and development advantages relying on its long-term industrial accumulation and unique geographical conditions, it still has obvious shortcomings such as insufficient high-end innovation resources, weak original innovation capabilities, and fierce urban competition and regional competition. For Dongguan, strengthening the source of scientific and technological innovation, benchmarking against Guangzhou and Shenzhen to enhance universities and national laboratories, amplifying the value of large facilities such as the Spallation Neutron Source, and improving basic research and core technology research capabilities are key; deepening Bay Area collaboration, actively integrating into the Guangzhou-Shenzhen-Hong Kong-Macao Science and Technology Innovation Corridor, establishing a division of labor of "Guangzhou-Shenzhen R&D + Dongguan Manufacturing", and undertaking the spillover of high-end resources are the way out; addressing urban shortcomings, using the Binhai Bay New Area as an engine, improving education, healthcare, and housing supply, optimizing the talent environment, and promoting the leap from a "manufacturing metropolis" to a "Bay Area advanced manufacturing and technological innovation center" is inevitable.

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